Title:
SYSTEM AND METHOD RELATING TO MOBILITY IN A MOBILE COMMUNICATIONS SYSTEM
SUPPORTING COMMUNICATION OF DATA


FIELD OF THE INVENTION
The present invention relates to a communication system which
supports communication of data and which comprises a first core
network with a plurality of core network functional server nodes
for circuit switched communication, also called CS core nodes, and
a second core network with a number of core network functional
server nodes for packet switched communication, also called PS
core nodes. At least the CS core nodes are arranged in a pool in
order to in common control a number of control nodes and an
interface between CS core nodes and PS core nodes is used e.g. for
providing information to CS core nodes from the PS core nodes
relating to mobility related events for mobile stations. The
invention also relates to a PS core node in such a system, to a CS
core node in such a system, to a home location node in such a
system and to a method for transfer of information messages in a
system as referred to above.


STATE OF THE ART
In known communication systems supporting communication of both
circuit switched data and packet switched data, as also very
schematically illustrated in the prior art figure 1, circuit
switched core nodes, here MSC 1 and MSC 2 and packet switched core
nodes, here SGSN 1 and SGSN 2 serve, or control, radio access
network control means, here base station controllers BSC 1, BSC 2,
BSC 3, BSC 4, each responsible for routing areas or location areas
RA/LA etc. It should be clear that the figure is most simplified

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and shown for illustrative purposes. Before the pooling concept
was introduced, i.e. without pooling, each BSC communicated with
but one CS core node and one PS core node, here each BSC
communicates with one MSC and one SGSN. If a mobile station MS
5    changes routing area or location area, for example between BSC 2
and BSC 3, the MSC has to be changed from the MSC 1 to MSC 2 since
BSC 2 communicates with MSC 1 and BSC 3 only with MSC 2. The MS
then sends a location area updates (LAU) to the MSC (corresponding
to a routing area update (RAU) for packet switched communication).
10   But it also means that it has to change SGSN, e.g. from SGSN 1 to
SGSN 2 in this case. This means that quite lot of signalling is
required, and there has to be sent one message to an MSC, one
message to an SGSN and a response or accept has to be awaited
from both. The procedure is similar upon attach, for example if
15   a mobile station within a routing area or a service area is not
moving but is activated in the area. In order to, among others,
reduce the required signalling a feature denoted combined
procedures has been standardized, it is also called Network
Operation Mode 1. In short this includes the introduction of an
20   interface, the Gs interface, between the SGSN and the MSC. An
advantage with this feature is that only one message is required
from the MS. The MS then instead sends a RAU of type combined to
the SGSN. (For example via broadcast the MS is able to note
whether the network supports RAU of type combined to an SGSN.
25   The SGSN then "converts" the RAU to a LAU which is sent over the
Gs interface to the concerned MSC (of course on condition that
the  concerned  MSC  and  SGSN  respectively  cover  the  same
routing/location area or service area. A benefit of using the Gs
interface is that CS paging can be coordinated in the BSC and
30   that mobility procedures such as attach and routing/location
area updates can be handled with a minimum amount of signalling
over the air. All mobility related signalling passes between MS
and the SGSN and, as referred to above, the SGSN then uses the

Gs interface to notify the MSC of the current mobility events. It should here be pointed out that, when the Gs interface is active, selection of an MSC is done by the SGSN and not by the BSC as it is otherwise the case. The Gs interface and combined

5    procedures are described in 3GPP (Third Generation Partnership Project) TS 29.018 and 29.016 which herewith are incorporated herein by reference thereto.

If however an MSC has been taken down e.g. because it was

10   malfunctioning for regular maintenance reasons or similar, and then it is activated or put into traffic again, it will not be aware of which MSs it should control. Therefore implementation of the pooling concept is a precondition for a good functioning. Pooling of core nodes, e.g. MSCs and SGSNs has been standardized

15   in 3GPP TS 23.236 Release 5, which also is incorporated herein by reference thereto. The pooling concept consists in that several MSCs or SGSNs serve one and the same area, i.e. serve the control nodes and the respective areas in common. This means that any core node, in a pool is able to control any control

20   node, e.g. BSC or RNC, in the pool area. This makes it possible, for example, to remove an MSC or an SGSN for service or maintenance purposes and still retain the service availability. It is also easier to add core nodes, MSCs or SGSNs, to the pool with a minimum impact on the pool and on control nodes since the

25   responsibility is taken over by another core node within the pool. Pooling is also attractive from load sharing and redundancy point of views. When an MS is attached to a pooled MSC/SGSN, it is allocated a temporary identity, TMSI (Temporary Mobile Station Identity) or P-TMSI (Packet-TMSI). (P-)TMSI)

30   includes an NRI (Network Resource ID) that uniquely defines the node in the pool, which is used by the radio access network control node, i.e. BSC or RNC, to route the MS to the ·correct MSC/SGSN. When the feature combined procedures, or the Gs

interface, is used together with pooled MSCs, the responsibility
for selection of MSC is transferred to the SGSN. According to
the current standards, the SGSN shall select MSC based on IMSI.
If for example a BSC, e.g. BSC 3, is served by SGSN 2, a RAU of
5    type combined is sent from BSC 3 to SGSN 2 which then sends a
LAU to an MSC. The selection of MSC is based on IMSI when SGSN
selects MSC. If, however, the MS has changed MSC, for example
due to maintenance or malfunctioning of an MSC, to another MSC,
allocation depending on IMSI will not function. All SGSNs have
10   to use the same algorithm or allocation algorithm in order to
assure that a MS does not have to change MSC when it changes
SGSN. Thus, if there has been a change in MSC, with the present
solution, it will not function. It is however disadvantageous to
change MSC selection just because an MSC has been taken down,
15   e.g. for algorithm due to maintenance etc. This is particularly
problematic when the MSCs are pooled and the SGSNs are not
pooled, or the SGSN pool area differs from that of the MSC pool
area, since the MSC selection or selection algorithm has to be
the same in all SGSNs to avoid change of MSCs SGSN change as
20   referred to above, i.e. all SGSNs have to choose the same MSC
for a mobile station.

In many cases, e.g. at MSC restart after a planned maintenance,
there is a need to have a more dynamic load sharing of MSs on
25   MSCs. If the SGSNs are aware that a certain MSC has been
restarted, or if there is a new MSC in the MSC pool, an active
load balancing can be performed in order to quickly redistribute
the load also on the new MSC. With the current solution this
would have to be performed using a coordinated change of the
30   IMSI based MSC selection algorithm, which means that the
consequences of even a planned operation will result in
extensive changes and signalling.

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In another situation MSCs apparently can move MSs to other MSCs
on their own initiatives before a maintenance situation. In that
case the SGSN to which the MS is attached is not notified. When
the MS notices the situation, a re-attach will occur, and the
5    SGSN will use its IMSI based algorithm to select an MSC, which
in most cases will lead to a change of MSC, which is
disadvantageous.

Thus, with the current solutions there will be unnecessary
10   changes of core nodes as a mobile station moves, as well as
there is required a lot of signalling in a network. Another
situation that is problematic is when an MS has changed MSC, and
then moves from one SGSN to another. The "new" SGSN then has to
select an MSC and accordingly uses the IMSI algorithm, e.g. an
15   IMSI table, and for example selects MSC 1. However, if the MS
had moved from the MSC 1 to another MSC, e.g. MSC 2, or if MSC 1
is out of operation or even if it has been taken into operation
after maintenance or similar, the MS will be controlled by
another MSC but this is not known to the new SGSN, i.e. the IMSI
20   algorithm will point at the wrong MSC, which is clearly
disadvantageous.

SUMMARY OF THE INVENTION
What is needed is therefore a communications system as initially
25   referred to in which signalling can be reduced. Still further a
communications system is needed through which unnecessary
changes of the attachment of a mobile station to core nodes can
be avoided in general. Moreover a system is needed through which
pooling of core nodes can be taken advantage of to a better
30   extent than hitherto, particularly pooling of CS core nodes.
Still further a system is needed through which the disadvantages
referred to above when pooling is used in combination with the
feature combined procedures or network operation mode 1 can be

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overcome. Further yet a system is needed through which maintenance of pooled CS core nodes, particularly MSCs, is facilitated when the Gs interface is active, or when combined procedures or Network Operation Mode I is implemented. Still

5      further a system is needed through which changes of core nodes can be avoided when for example a CS core node in a pool crashes, or when a new CS core node, particularly an MSC, is introduced in a network or when an MSC is down for maintenance reasons etc. Still further a system is needed through which the

10     rigidity and inflexibility of using MSC algorithms for selection of an MSC via an SGSN can be avoided and through which a coordinated change of IMSI based MSCs selections can be avoided when an MSC for some reason has been changed for one, or particularly a plurality, of mobile stations. Still further a

15     system is needed through which, even if a mobile station moves and changes SGSN attachment from one SGSN to another, it is not necessary to change MSC. Still further a system is needed through which, when there is a change in SGSN for a mobile station already having changed MSC, the SGSN shall have the

20     option to be aware of which is the current MSC. Still further a PS core node is needed through which one or more of the above mentioned objects can be achieved. Moreover a CS core node as initially referred to is needed through the implementation of which one or more of the above mentioned objects can be

25     achieved, as well as a home location node which can assist in achieving one or more of the above mentioned objects. Further yet a method is needed through which one or more of the above mentioned objects can be achieved.

30     Therefore a communication system as initially referred to is provided in which means are provided for, when there is a change from a first CS core node to which one or more MS(s) is/are attached to second core node, providing, from either of said

first or second CS core nodes involved in the change,
information to the PS core node to which the MS is attached,
with information that a transfer is to be done or has been done.
Particularly said means comprises means for providing and
5    sending a message from said first or second CS core node to said
PS core node. Particularly said message comprises a message
(here denoted a first information message) from said first CS
core node indicating the address of said second CS core node.
Said message may particularly comprise information about when
10   the PS core node should perform a location update towards said
second CS core node for each MS having moved or is going to move
from said first to said second CS core node.

In another implementation the first information message
15   comprises a message from said second CS core node, which message
comprises the address of said second CS core node itself.
Particularly that message is sent after the move (change) from
said first CS core node has been effected, and the second CS
core node has received information about the address of said PS
20   core node from said first CS core node.

In an advantageous embodiment, when a plurality of mobile
stations attached to a first CS core node are moved to, or to be
moved to, a second CS core node, information thereon is provided
25   to the PS core node substantially simultaneously, or for a given
number or for a particular group of such MSs simultaneously, or
consecutively, or according to some algorithm. This is
particularly relevant when for example an MSC or a CS core node
crashes, is taken down for maintenance or similar, and there may
30   be a large number of MSs being moved to fall under the
responsibility of another CS core node.

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In a particular embodiment the CS core nodes are MSCs whereas the PS core nodes are SGSNs and/or CGSNs. In one implementation the PS core nodes or particularly the SGSNs/CGSNs are not pooled. In that case the inventive concept is extremely
5   advantageous. However, in another implementation also the PS core nodes are pooled.

The first information message is particularly sent over the Gs interface and it should be followed by an acknowledgement from
10  the PS core node to the CS core node having sent said first information message. In order to solve the problem when a mobile station has moved/changed from a first CS core node to a second CS core node, and then subsequently changes PS core node from a first PS core node to a second PS core node due to change of
15  routing area, in which case, unless the inventive concept is implemented, the new PS core node having the IMSI algorithm, e.g. an IMSI table, at hands, and which is fixed for all SGSNs, would select the first CS core node and, in which case, since the MS has changed CS core node, it will no longer be there. In
20  order to solve this problem, second information means are provided for providing a new second PS core node, when an MS (or more) moves from an old first, PS core node to a new, second PS core node, with information about to which CS core node the MS currently is attached or connected. Particularly said second
25  information means comprises a second information message provided and sent from the first, old, PS core node to the second, new, PS core node and it contains information about current CS core node. Said second information message particularly comprises an existing message that already is used
30  in the messaging between PS core nodes, which however is extended with information relating to the current CS core node. As referred to above, the CS core nodes and the PS core nodes may be MSCs and SGSNs/CGSNs respectively. It may comprise an

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extended message (SGSN Context Response) during an Inter SGSN Routing Area Update. Particularly the current MSC forms part of a pooled group/list of MSC serving the current routing area/service area or location area of the new SGSN. Particularly the new, second, SGSN (or more generally the PS core node) selects the current CS core node or particularly MSC, and sends the message relating to Location Update (Location Update Request) to said current CS core node, or MSC, to avoid changing MSC for the mobile station.

In an alternative implementation said second information means comprises a second information message provided from a home location node, particularly an HLR, to the second, new, PS core node, which information message comprises information about the current CS core node. Said message particularly comprises an existing message extended with information relating to current CS node. Even more particularly, the CS core node comprises an MSC and the PS core nodes comprise SGSNs/CGSNs, and the existing message comprises an Insert Subscriber Data message in the MAP (Mobile Application Part Protocol). Particularly the second or new PS core node (SGSN) uses information about current MSC to send a Location Update Request to said current MSC (or CS core node) to avoid changing CS core node/MSC for the moving MS. Thus the feature that an HLR holds information about current CS core node is taken advantage of.

In order to achieve one or more of the objects initially referred to the invention also suggests a CS core node which is arranged in a pool of CS core nodes and which is used in a communication system supporting communication of data, further comprising a number of PS core nodes, and wherein an interface (Gs) is used for communication between CS core nodes and PS core nodes, wherein the CS core node comprises means for providing

information to a PS core node to which an MS is attached, when
said MS changes to/from said CS core node to another CS core
node. Said means particularly comprises means for generating and
sending a message to said PS core· node, and said message
5   contains the address of the other CS core node involved in the
CS core node change, i.e. a CS core node to which a change is
(to be) performed. Particularly said first information message
is sent when an MS is attached to the core node. Alternatively
said second information message is sent when an MS has been
10  detached/disconnected from said CS core node or when it is about
to detach/disconnect from said CS core node. Said first
information message particularly comprises information about
when the PS core node should perform a Location Update towards
the other CS core node. Particularly the CS core node comprises
15  means for sending a message/messages relating to a plurality or
group of MSs changing/having changed PS core node substantially
simultaneously. Particularly the CS core node comprises an· MSC
and said first information message is sent to an SGSN/CGSN
comprising a PS core node, wherein said information message is
20  sent over the Gs interface requiring an accept message from the
SGSN/CGSN.

The invention also provides for a PS core node used in a
communication system supporting communication of data and
25  comprising a number of PS core nodes and further comprising a
pool of CS core nodes and wherein an interface (Gs) is used for
communication between PS core nodes and CS core nodes. The PS
core node comprises means for receiving and responding to an
information message from a CS core node when one or more MSs
30  have changed/or are changing CS core nodes and contains the
address of the CS core node to which the MS or the MSs are
changing/have changed. Particularly said information message is
sent/responded to over the Gs interface and comprises

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information about when the PS core node should perform a
Location Update relating to the MS(s) towards the other/new PS
core node. The PS core node particularly comprises an SGSN/CGSN
receiving an information message from/responding to a CS core
5      node comprising an MSC. The PS core node particularly comprises
second information means for sending/receiving a second
information message to/from another PS core node to which an MSC
moves/attaches or has moved/attached or from which an MS has
moved, wherein said second information message contains
10     information about the current CS core node to which the MS is
connected/attached. Said second information message even more
particularly comprises an existing message extended with
information relating to current CS core node, particularly MSC.
The extended existing message particularly comprises an extended
15     SGSN context response used during an Inter SGSN Routing Area
Update. Particularly, after having received (taken over) an MS
from another PS core node, the PS core node selects the current
CS core node and sends a location update message to said current
CS core node, thus avoiding a CS core node change due to a PS
20     core node change for the mobile station in question.

In order to solve particularly the problem relating to the
situation when a mobile station changes from one PS core node to
another PS core node and where said other PS core node has to
25     select a CS core node as an alternative, the invention provides
for a home location node, e.g. a HLR used in a communication
system supporting communication of data and comprising a number
of PS core nodes and a number of PS core nodes. The CS core
nodes are arranged in a pool and an interface is used for
30     providing information from a PS core node to a CS core node,
e.g. the Gs interface and at least the CS core nodes are
arranged in a pool. The home location node comprises means for
providing and sending an information message (denoted second

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information message) to a PS core node when an MS has changed
attachment from another PS core node to said PS core node, about
current attachment/connection of the MS to a CS core node, a
current CS core node. Particularly said information message
5    comprises an existing message extended with second information
about current CS core node, wherein the existing message
particularly comprises an insert subscriber data message as used
in existing and standardized systems.

.0   The invention also suggests a method for transfer of information
messages in a communication system as initially referred to. The
method comprises the steps of, when one or more MSs being
attached/connected to a first pooled CS core node are (to be)
moved to a second pooled CS core node; providing information in
.5   a (first information) message from said first or second CS core
node about the address of the second CS core node to the PS core
node to which the MS or the MSs is/are connected. Particularly
the method comprises the step of using the Gs interface for the
message to the PS core node. Still further the method may
:0   comprise the steps of, when an MS having changed CS core and the
PS core node is aware of the address of the current CS core
node, and when the MS subsequently changes PS core node from a
first PS core node to a second PS core node, extending an
existing message intended for the second PS core node with
:5   information about the current CS core node; in a second PS core
node, using the information about the current CS core node;
selecting said current CS core node to avoid changing CS core
nodes for the mobile station(s). Particularly the extended
existing message is provided and sent from the old, first, PS
:0   core node or alternatively from the home location node holding
subscriber data for the mobile station, e.g. a HLR.

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BRIEF DESCRIPTION OF THE DRAWINGS
The invention will in the following be further described, in a
non-limiting manner, and with reference to the accompanying
drawings in which:
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Fig. 2        schematically illustrates a system according the
              invention and indicating one example of a possible
              scenario,


10   Fig. 3    is a sequence diagram in which a CS core node (an MSC)
              from which an MS is moved sends a first information
              message to a PS core node (SGSN),


Fig. 4        is a sequence diagram illustrating the procedure when
15            an MSC to which an MS moves informs an SGSN via a
              first information message,


Fig. 5        is a sequence diagram illustrating the procedure when
              an "old" SGSN provides information to a "new" SGSN
20            via an extended information message in a combined
              Inter SGSN RA/LA Update message, and


Fig. 6        is a sequence diagram similar to that of Fig. 5 for an
              embodiment in which the second information message is
25            provided from an HLR.


DETAILED DESCRIPTION OF THE INVENTION
Fig. 2 shows a system according to the present invention in
which a number of MSCs, MSC 1, MSC 2 and MSC 3 are arranged in a
30   pool, whereas a number of SGSNs, SGSN 1, SGSN 2 and SGSN 3 are
provided in a conventional manner, i.e. not in a pool (of course
also the SGSNs could have been arranged in a pool). The system
implements the standardized feature combined procedures or

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Network Operation Mode I as referred to above including the Gs
interface between the SGSNs and the MSCs. This means that all
mobility related signalling passes between the MSs within the
pool area (of which only one is illustrated for reasons of
5    clarity) and an SGSN, i.e. SGSN 1, SGSN 2 or SGSN 3, whereas the
respective concerned SGSN uses the Gs interface to notify the
MSCs or an MSC of the pool of mobility related events of the
mobile stations. As referred to above, a selection of an MSC for
an MS is performed by the SGSN in such a system instead of by
10   the BSC.

The pool of MSCs in common control BSC 1, BSC 2, BSC 3, i.e. any
of the MSCs, MSC 1, MSC 2, MSC 3, is able to control or serve
any one of BSC 1, BSC 2 and BSC 3. Of course, in a realistic
15   system there are far more BSCs, and mostly a pool includes more
than three MSCs. Since the pooling concept is not (in this
implementation) implemented on the SGSN side or on the packet
switched side, each SGSN communicates with one BSC or each BSC
only communicates with one SGSN. In this particular embodiment
20   BSC 1 communicates with SGSN 1, BSC 2 with SGSN 2 and BSC 3 with
SGSN 3.

Fig. 2 illustrates one scenario in which the problem is solved
when an MS is attached to an MSC and changes MSC, e.g. because
25   the MSC is taken down in a planned manner or crashes. SGSN
attachment is however not changed. As referred to earlier in the
application, an SGSN is here responsible for selection of MSC
based on the IMSI of the mobile station. If the SGSN is not
pooled or if the SGSN pool area differs from that of the MSC
30   pool, and since for a mobile station the same MSC has to be
selected by all the SGSNs in order to avoid an MSC change when
there is a SGSN change, with the current solution using the same
IMSI algorithm in each SGSN, the same MSC will always be

selected. If however an MSC is (taken) down, the SGSN will not be aware of that fact, which means the IMSI algorithm will no more select the appropriate MSC, or an MSC which is in operation. Thus, according to the present invention, means are provided through which the SGSN is notified about the change of MSC for one or more MSs.

In Fig. 2 it is for example supposed that MS is attached to MSC 1, but MSC 1 will be taken down e.g. due to a planned maintenance operation. It is here supposed that MS is transferred to MSC 2. In a first embodiment is supposed that the old MSC, i.e. MSC 1, notifies the SGSN, here SGSN 2, that for MS a change from MSC 1 to MSC 2 will occur. MSC 1 in this implementation thus sends a first information message "MS Move" (1) including the address of MCS 2 to SGSN 2 over the Gs interface. SGSN 2 then responds with an acknowledgment (2) to MSC 1. Subsequently, when a location update is due according to the first message (1), SGSN 2 sends a location update "MS Move" (3) to MSC 2 using the information it received in the first "MS move" message, i.e. the "new" MSC address and information about when the location update was to be performed towards the new MSC 2. MSC 2 then acknowledges (4) this to SGSN 2 also over the Gs interface. It should be clear that the inventive concept is not limited to the use of the Gs interface, the important thing being that the messages are provided and not how.

Generally, when an MS enters or switches on in a pool area, it sends an attach request of type combined to e.g. BSC 2 or a Routing Area Update (RAU) of type combined to BSC 2, which sends a LAU of type combined to SGSN 2 which uses the IMSI algorithm to select an SGSN. However, if not the message "MS Move" according to the present invention is used, and if the MS has changed MSC e.g. due to a maintenance operation or similar, the

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IMSI based allocation will not work any more since SGSN 2 (in this case) does not know where the MS is attached/connected or which MSC that should be selected; it would still use for example MSC 1 although it is taken down. All SGSNs, according to
5  current state of the art, do have the same IMSI algorithm among others in order to prevent that an MS changes MSC when it changes SGSN. Thus, according to the present invention it can be said that the IMSI based allocation is overridden, and due to the fact that the SGSN has got information about the current
10  MSC, the location update can be sent to the appropriate MSC. This is extremely advantageous since otherwise the algorithms would have to be changed in every SGSN for example at MSC maintenance operations etc.

15  The scenario of Fig. 2 is schematically illustrated in the sequence diagram of Fig. 3. Thus, it is here supposed that MSC 1 sends a first message Move MS ? (1) to MSC 2 to establish if MSC 2 is capable of accepting the MS. If MSC 2 accepts to receive MS, it sends an acknowledgement MS Move Ack (2) to
20  MSC 1. MSC 1 then sends a first information message according to the present invention, MSC Move, with information about the address of MSC 2 and information about when a location update towards MSC 2 is due, to SGSN 2 (3). This is acknowledged by SGSN 2 to MSC 1 in MSC Move Ack (4). Subsequently, when the
25  location update is due, SGSN 2 sends an MS Move Location Update message (5) to MSC 2, which acknowledges this, MS Move Ack (6), to SGSN 2.

It should be clear that generally an MSC handles a large number
30  of mobile stations and in such a case MSC 1 may send a message relating to a plurality of mobile stations, groups of mobile stations or all mobile stations to for example MSC 2 in one and the same message (on condition they are all moved to MSC 2;

otherwise there might be a message to MSC 2, a message to MSC 3
etc. depending on to which MSC a group of MSs are moved). It may
also according to any appropriate algorithm send a group within
a list to MSC 2, another group to MSC 3 etc. to handle the
5    situation in the most flexible manner with an amount of
signalling which is as much reduced as possible. Any variation
is in principle possible.

Fig. 4 shows an alternative implementation of the present
10   invention for informing an SGSN that an MS changes MSC (Of
course it is also applicable for a group moved from an MSC etc.)
In this case it is supposed that the new MSC, here MSC 2,
notifies the SGSN, here SGSN 2, after the MSC change actually
has taken place. The only information needed in the information
15   message in this case is the address of the new MSC. However
another requirement is that the old MSC, MSC 1, informs the new
MSC, here MSC 2, about the address of the relevant SGSN. Thus,
in the sequence diagram of Fig. 4, it is supposed that MSC 1
first sends a message move MS ? (1) to MSC 2 to establish if
20   MSC 2 can accept to handle MS (or a group of MSs or all MSs
handled by MSC 1). If MSC 2 accepts, it sends a MS move
acknowledgement (2) to MSC 1. MSC 1 then sends a message with
the address to the relevant SGSN to MSC 2 (3). Of course this
information about the SGSN address could have been included
25   already in the first message move MS ? (1) to MSC 2.
Subsequently it is supposed that the MS is actually moved
indicated through a dashed line (4) in the figure. When the MS
has been transferred to MSC 2, MSC 2 sends an MSC move with its
address to SGSN 2 (5). SGSN 2 then acknowledges the MS move (6)
30   to MSC 2. Preferably all messages and acknowledgments are sent
over the Gs interface. The fact that the old MSC sends the SGSN
address to the new MSC actually comprises an addition to the MSC
change procedure.

Fig. 5 is a sequence diagram relating to a first embodiment
according to which the problem is solved when there has been a
change of MSCs for an MS (cf. Figs. 2-4) and when the MS
5    subsequently changes SGSN which then has to select an MSC. It is
here supposed that the MSC has notified the SGSN about MSC
change e.g. according to the implementation described in Fig. 3.
or according to the implementation described in Fig. 4. The
implementation illustrated in Fig. 5 is based on an embodiment
10   in which, at Inter SGSN Routing Area Update, the old SGSN
includes the MSC address in the SGSN context response message
(together with all other MS subscriber data). Preferably the new
information elements are optional in order to assure that no
interoperability problems occur. If the information is not
15   included, an MSC change will occur, but the service will still
be available. This means that an SGSN is free to select any
algorithm to select an MSC, since the current MSC is
communicated to the new SGSN. Fig. 5 is based on the combined
Inter SGSN RA/LA Update in the implementation of the feature
20   combined procedures as described in 3GPP TS 23.060 version
5.2.0, release 5, section 6.9.1.3.2., incorporated herein by
reference.

The MS first sends a Routing Area Update Request as is known per
25   se to the new SGSN (1). Update Type preferably indicates
combined RA/LA update or if the MS wants to perform an IMSI
attach, combined RA/LA update with IMSI attach requested.
Subsequently the new SGSN sends an SGSN Context Request (2) to
the old SGSN, among others to get the PDP contexts for the
30   mobile station. The old SGSN thereupon sends an SGSN Context
Response which however, according to the present invention, is
extended with information about the current MSC to which the MS
is connected (3). This information is new. The new SGSN

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subsequently sends an SGSN Context Ack (4) to the old SGSN. Later the new SGSN sends an Update PDP Context Request (5) with the new SGSN Address TEID, QoS Negotiated to the concerned GGSN (Gateway GPRS Support Node) and the GGSN update their PDP

5    context fields and return an Update PDP context Response (TEID) (6).

The new SGSN sends an Update Location to HLR to inform the HLR of the change of SGSN by sending Update Location with SGSN

10   Number, SGSN Address, IMSI (7). The HLR then sends a Cancel Location with IMSI, Cancellation Type, to the old SGSN (8). The old SGSN acknowledges this with Cancel Location Ack (IMSI) (9). HLR sends Insert Subscriber Data (IMSI, GPRS Subsription Data) .(10) to the new SGSN which validates the presence of the MS in

15   the (new) RA. It is here supposed that the MS is allowed to be attached in the RA in question and the new SGSN returns an Insert Subscriber Data Ack (IMSI) message to HLR (11). The HLR acknowledges the Update Location by sending Update Location Ack (IMSI) to the new SGSN (12). Since the new SGSN has been

20   provided with information about current MSC, it directly sends a Location Update Request to current MSC (13), which, if it accepts, returns a Location Update Accept (14), to the new SGSN. As can be seen here a lot of messaging and signalling is avoided due to the fact that new SGSN already in message (3) was

25   informed about current MSC. Finally the new SGSN validates the presence of the MS in the new RA. It is supposed that the MS is allowed to be attached in the RA and subscription requirements are met and thus the new SGSN establishes MM and PDP context for the MS and a logical link is established between the new SGSN

30   and the MS.

The new SGSN responds to the MS with a Routing Area Update Accept with P-TMSI, VLR TMSI, P-TMSI Signature etc. (15). The MS

then confirms the reallocation of the TMSIs by returning a Routing Area Update Complete to the new SGSN (16). The new SGSN then sends a TMSI Reallocation Complete message to the new VLR if the MS confirms the VLR TMSI. This is however not shown in
5    the figures since it is of no relevance for the present invention.

Thus, Fig. 5 describes one way of providing an extended, existing message with information such as to achieve the object
10   of the invention and to reduce signalling and prevent unnecessary MSC changes (upon an SGSN change).

Fig. 6 shows another implementation of the invention which is an alternative to the implementation described in Fig. 5. In this
15   case it is the HLR that provides the information about current MSC. During attach and Inter SGSN Routing Area Update, when the SGSN receives insert subscriber data from the HLR, the HLR includes the address of the MSC where the MS currently is attached (if one is available). If this MSC is one of the MSCs
20   which are pooled as known to the SGSN, this MSC will be used for the combined procedures and an MSC change is avoided for the MS. Actually both these implementations have as a consequence that an SGSN is free to chose any algorithm to select MSC, since the current MSC is communicated to the new SGSN. In Fig. 6 signals
25   1-9 correspond to those of Fig. 5 with the exception that in message 3' current MSC information is not included. However, instead in the insert subscriber data message 10' from HLR to the new SGSN, this message is extended with the information about the current MSC, with subsequently is acknowledged in a
30   message 11' from the new SGSN to HLR.

Thus, the HLR notifies the SGSN of the MSC where the MS is attached. This actually comprises an update to the Insert

Subscriber Data message in MAP (Mobile Application Part), 3GPP
TS 29.002 which herewith is incorporated herein by reference.
Upon receiving the MSC address the SGSN can send the Location
Update Request message to the MSC where the MS already is
5   attached. One requirement for the SGSN to use this MSC is that
the MSC belongs to the list of MSCs (pooled) that served the
current RA/LA. The other messages than the one particularly
discussed above correspond to those in Fig. 5. Thus, messages
1',2', 4'-9' and 11'-16' corresponds to messages with the same
10  references in Fig. 5).

In still another advantageous implementation of the invention
the SGSN is provided with a monitoring function of all
configured MSCs of the pool in order to detect an MSC failure.
15  Then the SGSN can send all new MSs or redistribute MSs to the
restarted, or another, MSC when it is available. In order to
make the monitoring function work, either of the suggestions
provided in Figs. 3,4 or 5,6 has to be implemented, or a
combination thereof. When an MS has been redistributed, it will
20  be attached to a new MSC, which means that when the MS changes
SGSN, e.g. at an Inter SGSN Routing Area Update, the new SGSN is
able to find the MSC to which the MS is connected.

It should be clear that the invention of course not is limited
25  to the specifically illustrated embodiments, but that it can be
varied in a number ways without departing from the scope of the
appended claims.

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